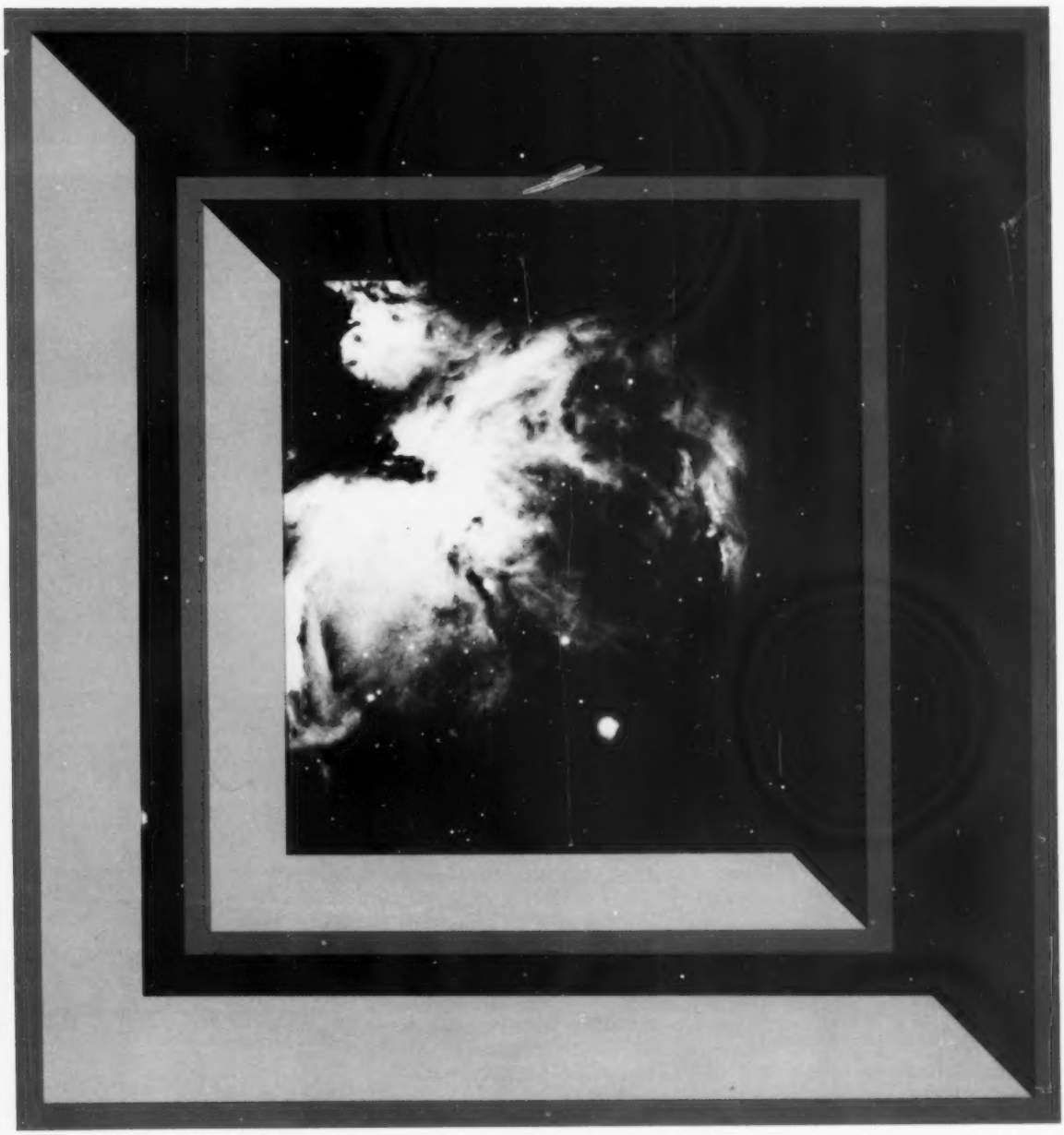
THE TECHNICAL NEWS BULLETIN OF THE NATIONAL BUREAU OF STANDARDS October 1974

DIMENSIONS/NBS



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Cover: The most complex organic molecule yet detected in interstellar space—dimethyl ether—was observed by a team of physicists and astronomers in the direction of the Orion Nebula molecular cloud. The established presence of organic molecules in space may have an important bearing on the question of the origin—or origins—of life and its existence in other parts of the universe. See story on page 228.

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

The Institute for Basic Standards
The Institute for Materials Research
The Institute for Applied Technology
The Institute for Computer Sciences and Technology
Center for Radiation Research
Center for Building Technology
Center for Consumer Product Safety

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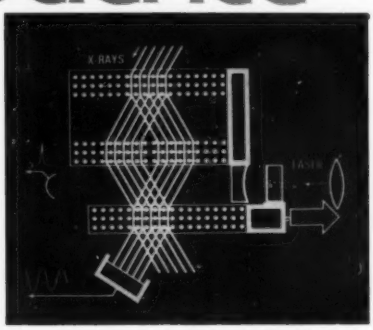
Avogadro Constant Determination Sparks Advances in Measurement Science

Accuracy of the constant is improved thirty-fold.



Schematic of x-ray/optical interferometer.

IN a major contribution to the art of precise measurement, scientists at the National Bureau of Standards have completed a new determination of the Avogadro constant, equivalent to weighing an atom, with an accuracy of 1 part in a million (ppm).

The new value of the constant was obtained by measurements on near-perfect single crystals of silicon made available by present-day solid-state electronics technology.

The experiment is important not only for the improvement in accuracy of the Avogadro constant, but because it has taken genuinely new approaches in all three components of the determination: density, spacing of atoms in a crystal lattice and (relative) atomic weight.

Measurement of the density of silicon crystals was made from first principles, rather than being based on an assumed value for the density of water. Density values of highly perfect steel balls were established by dimensional metrology (volume) and weighing. These objects were then compared with silicon crystals hydrostatically. Experience indicates the silicon crystals are quite stable density artifacts and they are now used by NBS to make density measurements for industrial and scientific laboratories with accuracies almost 10 times better than obtained before.

To measure the lattice spacing of the silicon crystal, an x-ray/optical interferometer was developed that measures linear displacements to within one-hundredth of the diameter of an atom (10^{-2} Å). It provides two sets of fringes, one produced by x-rays in a silicon crystal interferometer, the other by a stabilized laser in a Fabry-Perot cavity, which are simultaneously used in measuring the same baseline.

Measurement of the average atomic weight of the atoms in the silicon crystals was made by an "absolute" method, comparing the crystals with a synthetically prepared mixture of high purity isotopes. Samples that have been calibrated against the synthetic mixture are available to the public as Standard Reference Material (SRM) 990.

A more direct connection of the Avogadro constant with measurement science is that once it is known with sufficient accuracy—and the present measurement takes another step towards the goal—it will be possible to replace the prototype kilogram by an atomic standard of mass.

The Larger Program

The Avogadro project is one part of a larger program which aims also at attaining a homogeneous wavelength scale that embraces the visible, x-ray and gamma-ray spectral regions, and a measurement of the electron's Compton wavelength.

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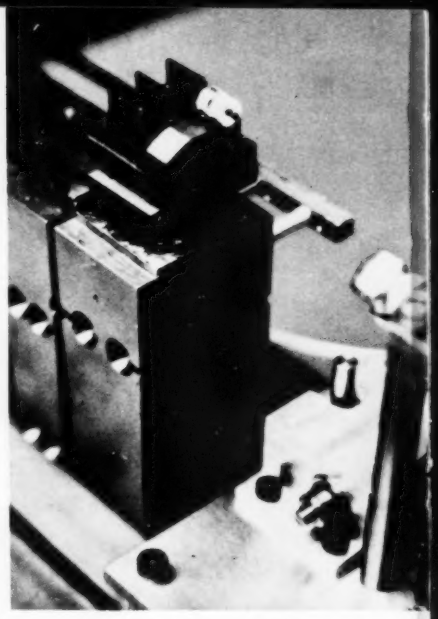


Critical portion of the x-ray/optical interferometer, with which the lattice spacing of a silicon crystal was measured, showing the three silicon crystal wafers.

AVOGADRO *continued*

In this program, x-ray wavelengths of two commonly used x-ray wavelength standards (Cu $K\alpha_1$ and Mo $K\alpha_1$) have already been compared accurately with optical wavelengths. These were determined with an accuracy close to the limit permitted by the x-ray lines themselves.

Dr. Richard D. Deslattes, chief of the NBS Quantum Metrology Section, who has played a central role in the larger program, was project leader for the Avogadro constant determination. The density measurements were made by Horace A. Bowman, Randall M. Schoonover and Clarence L. Carroll of NBS' Mass and Volume Section; the relative abundances of the silicon isotopes were determined by Dr. I. Lynus Barnes, Lawrence A. Machlan, Dr. Larry J. Moore and William R. Shields of NBS' Isotopic Analysis Section; and the lattice spacing measurements were made by Deslattes and Dr. Albert Henins also of NBS' Quantum Metrology Section.

The Avogadro Constant

The Avogadro constant is the number of atomic mass units in 10^{-3} kilogram (1 gram). Equivalently, it is the number of atoms or molecules in a mole of substance.

To obtain the Avogadro constant (N_A) from the density (ρ), atomic weight (A) and lattice parameter (a_0), use is made of the Bragg equation:

$$N_A = nA/\rho a_0^3$$

where n is the number of atoms in an elementary cubic cell of the crystal (for silicon, n=8). The equation says simply that the Avogadro constant is the number of atoms per elementary cell divided by the number of moles per cell.

The result obtained in the NBS measurement is:

$$N_A = 6.0220943 \times 10^{23} \text{ mol}^{-1}$$

with an uncertainty of 1 ppm.

This result differs by 8 ppm from the value given in the 1973 Adjustment of the Fundamental Constants (Dimensions/NBS, Jan. 1974, p.3), a value obtained indirectly from the relations of the Avogadro constant to other physical constants. A calculation by Dr. Barry N. Taylor, who collaborated on the 1973 Adjustment with Dr. E. Richard Cohen, shows the new value to be reasonably consistent with the results of the 1973 Adjustment.

XROI

The x-ray/optical interferometer (XROI), one of the world's most refined measuring engines, measures the distance traveled by its moving carriage to the nearest hundredth of an angstrom (10^{-2} Å = one millionmillionth of a meter).

Fixed to the XROI frame are two silicon crystals, one (hemispherical) plate of an optical Fabry-Perot (F-P) interferometer and detectors of x-ray and optical (He-Ne laser) radiation. A third silicon crystal and the other F-P plate are on the movable carriage. To mention just one of the formidable design problems that were overcome, the orientation of the moving crystal must be maintained within a thousandth of a second of arc.

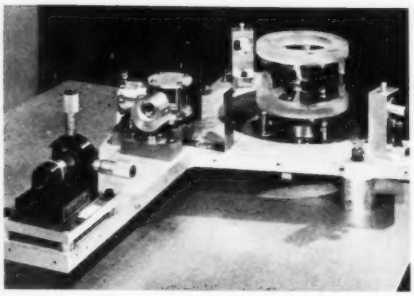
A beam of x-rays passes through the three crystals, a small part of it reaching the x-ray detector. Because the crystals act as three-dimensional diffraction gratings (without going into further detail), the intensity of the x-rays falling on the detector varies through one intensity cycle every time the carriage advances through one lattice spacing.

The x-ray detector thus serves to count the number of elementary lattice periods through which the carriage is displaced. In the Avogadro experiment, a length of about 150,000 lattice spacings was covered. Simultaneously, the F-P interferometer measures the same distance in SI units. Combining the outputs of the two detectors, the lattice spacing, and thus a_0, was obtained with an uncertainty of 0.25 ppm.

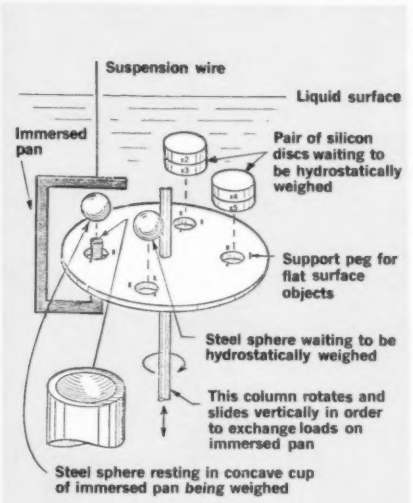
Isotopic Abundances

Although the Isotopic Analysis Section has an ongoing program for the redetermination of atomic weights through measurements of isotopic abundances, the silicon crystals presented special problems.

One was the design of a mass spectrometer to handle the silicon as a gas, a form in which it is more readily ionized. To get the silicon in gaseous form, it was converted to SiF_4. A narrow beam of SiF_4 molecules in the mass spectrometer was then ionized by high voltage electron bombardment into SiF_3^+. Passed through a strong magnetic field, each ion moved in a path whose curvature depended on its mass, which depended on the silicon isotope it con-



Interferometer for measuring diameters of steel spheres used as reference density standards.



Immersed pan loading mechanism employed in comparing the volumes of the steel sphere density reference standards with the volumes of silicon discs.

tains. The single beam consequently split into three, containing Si-28, -29 and -30, respectively. Each beam was then caught in a separate collector.

The main problem was achieving the required accuracy, which was accomplished by calibrating the spectrometer with a synthetically prepared mixture of isotopes closely matching the proportions in the silicon crystals. The biggest hurdle was assaying Si-28 and Si-30 to a part in 10^4, well beyond what had previously been attained. This was made more difficult by the small quantity (30 milligrams) of Si-30 that was available (it was supplied by Oak Ridge National Laboratory).

The average atomic weight of the silicon in the crystals was then calculated from the measured abundances and the atomic weights of the separate isotopes (known to a part in 100 million).

Density Without Water

Most of the novel features of the new density procedure flow from the decision to use solid reference standards of density—the average density of each of six steel spheres—instead of water. It happens that spheres suitable for the purpose are available inexpensively from manufacturers of inertial navigation devices.

The masses of the spheres, conveniently close to 1 kilogram each, were obtained in terms of the international kilogram—via the U.S. national standard of mass (kilogram no. 20)—to better than 1 part in 10 million.

Their volumes were calculated from averaged, interferometrically measured diameters (about 6.35 cm). James B. Saunders (now retired) of the Optics and Micrometrology Section, well known for his many contributions to interferometry, designed the special interferometer used. A study by Dr. Daniel B. Johnson of the Mechanics Division showed that the small deviations of the spheres from roundness had a negligible effect (less than 1 part in 10^{11}) on the calculated volumes.

But since steel was considered too easily scratched or otherwise altered by use, four pieces of single crystal silicon were chosen to serve as the working standards. The volumes of the crystals were found by comparing their loss of weight on immersion in a liquid with the weight loss of the steel spheres in the same liquid.

The liquid was not water, but a fluorocarbon, which is superior in several respects. Its density is roughly twice that of water, so weight losses can be measured with about twice the precision. It has an enormous appetite for gases, so that it is much more successful in dissolving the tiny air bubbles that cling to the object and thereby alter the measured volume. Other advantages stem from the fluorocarbon's much lower surface tension.

Finally, for the purpose of the Avogadro experiment, the density of three other silicon crystals, one cut from the same "boule" as the crystal whose lattice spacing was measured with the XROI, were determined by comparing their volumes with those of the working standards, using the procedures just described.

Those working with the new density method expect further improvements in the near future and that

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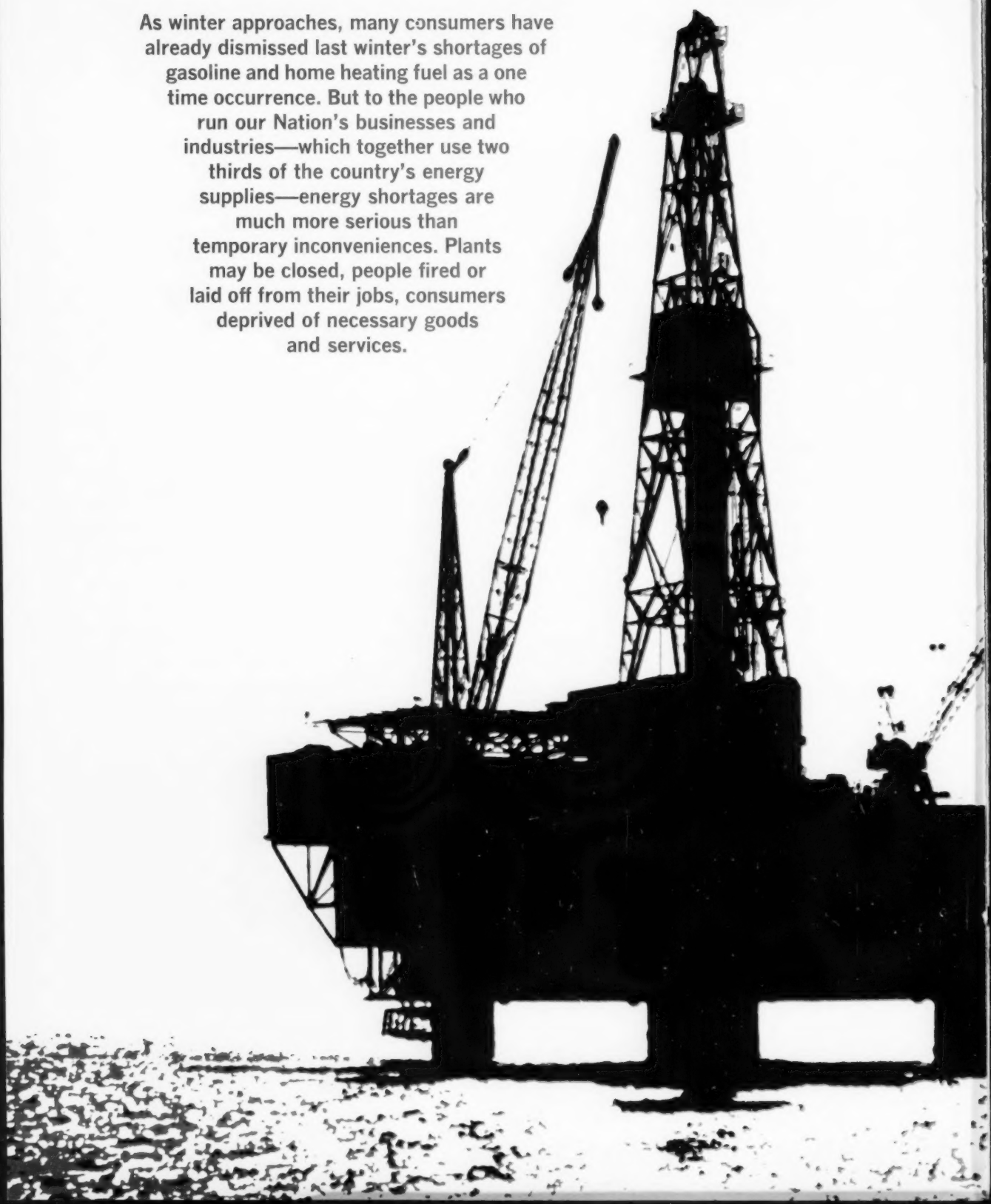
As winter approaches, many consumers have already dismissed last winter's shortages of gasoline and home heating fuel as a one time occurrence. But to the people who run our Nation's businesses and industries—which together use two thirds of the country's energy supplies—energy shortages are much more serious than temporary inconveniences. Plants may be closed, people fired or laid off from their jobs, consumers deprived of necessary goods and services.



NBS Assists Industry and Commerce with an EPIC

THE clear fact is that today the United States is facing a national energy shortage unprecedented in its implications for the continued prosperity and growth of our country. To help the business community use the Nation's energy supplies more efficiently, the National Bureau of Standards has published the Energy Conservation Program Guide for Industry and Commerce (EPIC).

EPIC was prepared with support from the Federal Energy Administration (FEA) and is designed to provide technology information transfer to small and medium sized companies in the field of energy conservation. Published as NBS Handbook 115, EPIC is based on the successful energy conservation programs and case histories from a variety of firms, some of which have reduced energy use by 15 to 30 percent without disrupting productivity.

NBS Director Dr. Richard W. Roberts notes that "EPIC promises to become one of the Department of Commerce's most important tools in its continuing program to help industry and commerce use energy supplies more efficiently. Potential users of the guide include thousands of manufacturing firms and small businesses."

Roberts' assessment is borne out by reviewers of EPIC who represented a cross section of American industry and commerce as well as universities. Among reviewers of EPIC were members of Secretary of Commerce Frederick Dent's National Industrial Energy Conservation Council. Reflecting the opinions of many reviewers, one commented, "The EPIC report represents the most practical and down to earth document on energy conservation which I have seen."

Specific Examples

EPIC had its genesis nearly a year ago, according to Robert Massey of the Technical Analysis Division (TAD) of the NBS Institute for Applied Technology. He was attending an energy conference last year in New York when he realized that a lot of people in industry were seeking specific ways to deal with energy conservation.

"People not only wanted to know how you get an energy program started," says Massey, "but what you do specifically in an energy program. EPIC goes beyond the usual, general checklists of areas where energy can be conserved. EPIC provides specific examples and evaluations of what has been and can be done to save energy."

Dr. Robert Gatts, also of TAD, and Massey began to collect specific examples from companies with successful energy conservation programs. Working together with John C. Robertson, a NBS research associate who is the energy conservation coordinator for the Texas Division of Dow Chemical, they put EPIC together. The work was performed in TAD under the direction of Dr. Jack Snell, the Bureau's Energy Conservation Program Manager, in the Center for Building Technology.

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Conserving Energy Through Appliance Labeling

Excerpted from a speech given recently by Dr. Melvin R. Meyerson, Chief of NBS' Product Evaluation Technology Division, before the Conference on Improving Efficiency in Heating, Ventilation and Air Conditioning Equipment.

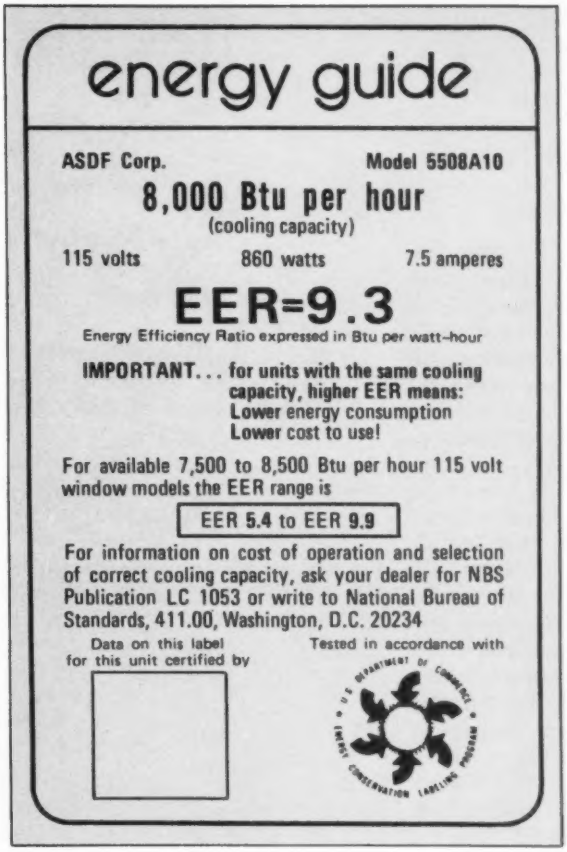
JUST as the causes and effects of the Nation's current energy shortage are many and complex, so the Federal response to this problem has taken many specific forms.

One very important approach aimed at alleviating the immediate energy problem is energy conservation. This approach is essential until energy production can be increased; and it holds even greater future importance as the United States strives for energy self-sufficiency in a world of limited resources.

We know that approximately 20 percent of all energy consumed in the United States is used in apartments and single-family dwellings. Much of this undoubtedly goes to operate the vast number of appliances found in homes. These include, for example, some 31 million room air conditioners, 70 million refrigerators, 23 million freezers and 55 million water heaters. In 1973 alone, well over 43 million major appliances were sold throughout the United States. If only one-half of one percent of the energy now used in residences were saved, this would amount to a savings of 65 trillion BTU's per year.

It is quite possible to achieve savings of such magnitude by fostering greater efficiency in the use of energy required to operate household appliances. For example, some more efficient appliances may require two or three times less energy to perform the same service as do other directly competitive though less efficient models.

In order to exploit this possibility, at least two conditions must be met: first, consumers must be provided with information to enable them to determine the relative efficiency of competing appliances; and second, sufficient numbers of consumers must buy the most efficient appliance models that will suit their own needs.



Sample of the energy labels now found on many room air conditioners. Eighteen manufacturers are currently participating in the voluntary energy labeling program.

Appliance Labeling Program

On April 18, 1973, the President issued an Executive Order directing the Department of Commerce, in cooperation with the Environmental Protection Agency and the Council on Environmental Quality, to develop a voluntary labeling program which would apply to energy-consuming home appliances and equipment. The goal of the program is to encourage manufacturers to provide consumers, at the point of sale, with information on the energy consumption and energy efficiency of household appliances and equipment. The National Bureau of Standards, within the Commerce Department, serves as the technical support agency for the labeling program.

Appliances to be labeled under the program include room and central air conditioners, refrigerators, freezers, refrigerator/freezers, water heaters, dishwashers, clothes washers, clothes dryers, kitchen ranges and ovens and comfort heating equipment. Two principal criteria were used in selecting appliances to be included under the program: 1) the appliances, as a class, were deemed significant energy users, and 2) there appears a relatively wide range of efficiencies available within each product class.

The Federal Role

The Federal role in the labeling program is to provide operating guidelines and technical information for manufacturers' compliance with established procedures. The Government is also sponsoring a public information effort designed to promote the use of the label. And finally, the Government is responsible for evaluating the overall effectiveness of the program.

The full specifications defining all labeling requirements, prepared by NBS, are published in the *Federal Register*. Thirty days are ordinarily allowed for receipt of comments from all interested parties. These may include Federal, State and local agencies, manufacturers, distributors, retailers, consumers, environmentalists and others. Informal hearings on the specification may also be held upon request. After due consideration of all comments received, and usually 30 days after the final date for receipt of comments, a notice will be published in the *Federal Register* indicating the action to be taken.

Test Method Selection

Our most important technical problem in developing specifications is concerned with identifying test methods that are reproducible, that are fair to all manufacturers and that will produce information which is understandable and meaningful to consumers. We prefer, whenever possible, to rely on test methods that exist as published standards; or, we may request the industry to develop a workable test method. Only if all else fails will NBS actually undertake to develop the test method.

Industry Cooperation

Room air conditioners constitute the first product class to receive the Energy Guide Label. Cooperation of the industry can best be described as "excellent." Within 4 months after publication of the final air conditioner specification, 18 manufacturers

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Technical Sales Seminars Open Doors Overseas

YUGOSLAVIA, Mexico and Brazil all have at least one thing in common. They are on the growing list of countries that have hosted U.S. Department of Commerce Technical Sales Seminars.

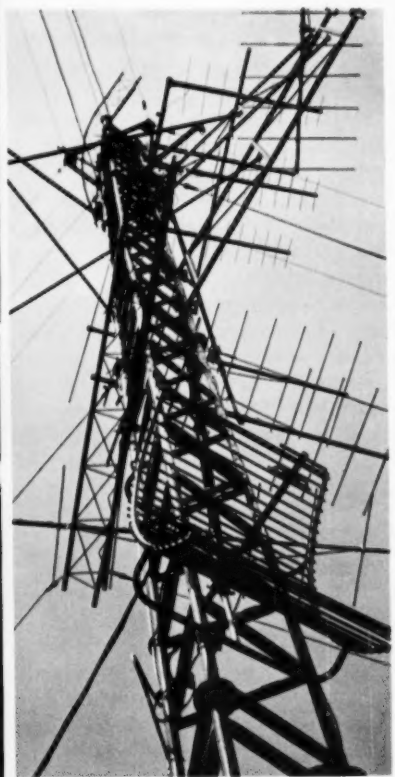
Billed as "specialized export promotion events," Technical Sales Seminars are a relatively new addition to Commerce programs aimed at boosting U.S. exports, especially in high technology areas. As a result of the five seminars held last fiscal year, for instance, the United States will gain between $55 to $57 million in exports over the next 2 years, estimates Wyn Coates, who oversees the program at Commerce. He is planning 12 seminars this fiscal year.

Although he admits $57 million is a drop in the bucket compared to total U.S. exports running into billions of dollars, Coates maintains that the seminars play a very important role.

As he describes them, they combine the most desirable features of a symposium, designed to explain in general terms the latest in U.S. technology, and a trade mission, long used to discuss and promote sales of U.S. equipment and systems abroad.

Coates' assessment of Technical Sales Seminars is backed enthusiastically by Dr. John Taylor, chief of the Air Pollution Analysis Section at the National Bureau of Standards (NBS). Taylor had first hand experience as chairman of a recent seminar that traveled to South America.

In addition to helping introduce U.S. products and expand markets, the seminars help facilitate exchange of information between countries and foster better relations with people of foreign countries, Taylor believes.



High Technology Markets

The first question most people ask Coates and Taylor is "What exactly is a Technical Sales Seminar?" Usually a seminar consists of a team of six to eight U.S. industry representatives and a "nonpartisan" chairman who visit as many as three countries for about 18 days. The key ingredient, explains Coates, is a 1- to 2-day session in each country featuring presentations by the U.S. representatives in a given high-technology industry. The sessions last month in Yugoslavia, Romania and Poland, for instance, were on telecommunication equipment and systems. A seminar scheduled for December will feature cryogenic equipment. The seminar chairman will be Dr. Richard M. Kropschot, chief of NBS' Cryogenics Division.

The presentations focus on general information about a given product or aspect of the industry without emphasis on the representative's own particular product, Coates stresses. "While they are in the seminar, the U.S. seminar members represent U.S. industry as a whole," he says. After the technical sessions, U.S. industry representatives make site visits to companies and other facilities of interest.

Seminars are usually requested by the host country. For each seminar, the U.S. companies pay their own transportation and expenses. The Commerce Department pays the expenses of the chairman and the on-site expenses of interpretation and conference facilities.

Chairman's Role

On Taylor's mission to South America, he was accompanied by representatives from six U.S. companies that make and market analytical and process analysis instrumentation. Seminars and site visits were held in Sao Paulo, Brazil, and Bogota, Colombia, with site visits only in Rio de Janeiro, Brazil.

Taylor served as leader and spokesman for the nine man, one woman delegation, chaired the seminar sessions and gave an overview talk to set the stage for the presentations.

In his overview, he emphasized the need for accurate measurements in both science and industry, discussed the importance of both good methods and adequate quality control procedures and described improved measurement techniques, including the use of Standard Reference Materials (SRM's) to provide accuracy and measurement reliability. He also conferred with local leaders and industrial scientists on a variety of subjects such as U.S. pollution control programs, international standardization activities, the NBS program of SRM's and exchange of technical information.

Breakthrough for Small Companies

U.S. members of the seminar included representatives from Gelman Instrument Co., Hoke International, Houston Atlas, Modern Controls, Texas Nuclear, and Hubert Lando, Jr., Inc. All give high marks to Commerce and State Department officials involved in planning the trip.

Charles Kimbell of Houston Atlas, a company that makes gas analyzers for hydrogen sulfide and total sulfur, sees the Technical Sales Seminars "as an excellent way for small companies to break into foreign markets." Prior to the trip, his company had foreign sales amounting to 15-20 percent of its total sales, but Houston Atlas had not been familiar with the Brazilian or Colombian markets.

Another seminar member, Hubert Lando, who heads his own export management company, thinks it is one of the best government programs he knows.

This is due, in part, to the careful and detailed planning of U.S. embassy personnel on site, explains Ted Johnson, an advance officer who accompanied the Taylor mission. Johnson, who is with Commerce's Office of International Marketing, points out that U.S. embassy people lined up key executives and operational personnel from the petroleum, petrochemical, paper, steel and food industries and university decision makers. "Despite attempts to keep the seminars small, the interest was so great that there was standing room only at the seminars," he says. "When people came, they stayed all day."

Participants' companies, five of which were new to Brazilian and Colombian markets, reported immediate sales of $154,000 and they anticipate sales over the next year of more than $1.75 million, Coates relates, and longer term prospects are even brighter.

In the case of his own mission, Taylor thinks that the NBS contribution to the seminars is important. "The seminars give NBS a new valuable way to cooperate with industry. But NBS also gives a lift to the seminars because of its reputation for integrity and excellence abroad." Perhaps more important, says Taylor, "Under U.S. sponsorship, doors are opened overseas that U.S. industry may never have thought existed." □

Biomolecules in the S

Scientists detect the largest organic molecule found so far in interstellar space

WITH radiotelescopes pointed in the direction of the Orion Nebula, a team of physicists and astronomers have picked up microwave radiation that they have identified as coming from molecules of dimethyl ether (CH_3OCH_3), the most complex organic molecule yet found in interstellar space.

The discovery shows that relatively large organic molecules can be produced out in space in sufficient quantities to be detected. Only a few years ago it was thought that the interstellar environment made it practically impossible for even the simplest organic molecules to form. Or if they did form, ultraviolet radiation from the stars would soon tear them apart.

The established presence of organic molecules in space may have an important bearing on the question of the origin—or origins—of life and its existence in other parts of the universe.

National Bureau of Standards scientists Lewis E. Snyder, Frank O. Clark, Donald R. Johnson and Frank J. Lovas collaborated in the discovery with David Buhl of the National Radio Astronomy Observatory (Greenbank, W. Va.), Philip R. Schwartz of the Naval Research Laboratory (NRL) and Paul T. Giguere of the NASA Goddard Space Flight Center. Snyder is a Visiting Fellow, on leave from the U. of Virginia, at the Joint Institute of Laboratory Astrophysics, administered jointly by the U. of Colorado and NBS. Clark is an NRC-NBS Postdoctoral Fellow at NBS.

"Dust" Does It

With almost 30 different interstellar molecules (most of them organic) now identified, the view is gaining ground that their existence is made possible by clouds of "dust," extremely small solid particles that screen out much of the ultraviolet radiation. It is also believed likely that some molecules are formed on the surface of dust particles, which act as catalysts in the process.

According to a theory widely held by astronomers, new stars—often with attendant planets—are born in interstellar space by condensation of the matter thinly spread through those vast regions.

The dimethyl ether molecules were detected by radiotelescopes at the NRL Maryland Point Observatory and at the NRAO station at Kitt Peak in Arizona.

Discovery of interstellar dimethyl ether was no accident, but came after a deliberate search guided by laboratory measurements of the wavelengths emitted by the molecule. Identification was made on the basis of three different radiations observed at wavelengths close to 3.3, 3.5 and 9.6 millimeters. The 3.3-mm radiation was received from the Orion Nebula molecular cloud, the other two were from the region known as Sagittarius B2, approximately in the direction of the center of the Galaxy.

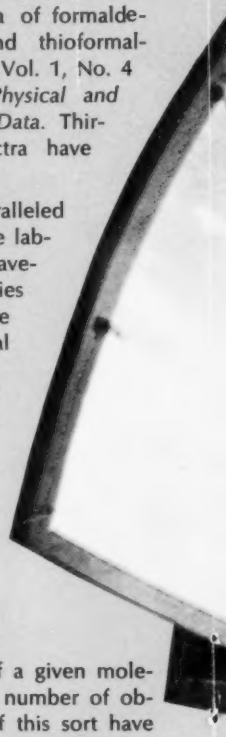
A few dimethyl ether microwave wavelengths were already given in the literature. For the present project, these lines were remeasured and the wavelengths of additional lines determined in the NBS microwave spectroscopy laboratory.

Information Center

Considerably more laboratory information about the spectrum of dimethyl ether was obtained than was of immediate use, and this is being subjected to detailed analysis at NBS, a primary center of information about molecules of astrochemical interest.

For several years now, Johnson, Lovas and others have been gathering the available data and making critical reviews of the microwave spectra of selected molecules—for example, the spectra of formaldehyde, formamide and thioformaldehyde, published in Vol. 1, No. 4 of the *Journal of Physical and Chemical Reference Data*. Thirteen molecular spectra have been reviewed so far.

They have also paralleled and supplemented the laboratory-determined wavelengths and frequencies by calculating a large number of spectral lines, applying quantum methods to the structural symmetries of the molecules.



Special "finding" tables have been prepared, listing the data according to frequency, making it easy to see if a reported frequency is in the spectrum of a given molecule. A considerable number of observed frequencies of this sort have been submitted by radioastronomers, and have been successfully matched to numbers in the tables with a batting average of about 50 percent.

With the intensified search of the last few years for further molecules

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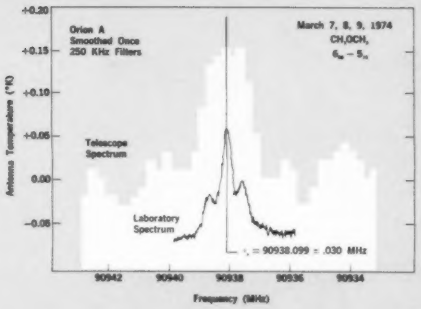
Sky

Photo courtesy of National Radio Astronomy Observatory and J. Conners Graphic Films, Inc.



Spectrum of radio signal from Orion Nebula compared with laboratory spectrum of dimethyl ether.

BIOMOLECULES *continued*

in space and the lengthening list of molecular candidates for discovery, the amount of data has stretched the NBS facilities. Some of the work is therefore being shared with other scientists in this country and Europe.

Fundamental Chemistry

The main thrust of research by the NBS microwave spectroscopy group is in fundamental chemistry—where physics and chemistry overlap—and specifically in the study of free radicals and other unstable molecular combinations of atoms. Because of their short lifetimes under laboratory conditions, most of these have never been observed on earth. Paradoxically, a number of them have been found in interstellar space, an environment once thought unfavorable to almost any kind of molecule.

This explains the alliance between the NBS microwave spectroscopists and the radioastronomers. It can be expected that our knowledge of how molecules form and transform will increase along with our understanding of conditions in interstellar space, as determined from the kinds and relative abundances of the molecules present and the characteristics of the radiations emitted.

Also, as we have seen, laboratory studies can guide the search for new interstellar molecules. An interesting case is that of thioformaldehyde (H_2CS) which was detected for the first time at NBS by Johnson and Francis X. Powell, who further suggested that it might also be found in space. The H_2CS was generated in the laboratory under continuous-flow conditions by reacting the products of a radiofrequency discharge in methane with carbon disulfide downstream from the discharge. Its structure and moments of inertia were deduced from measurements of its microwave frequencies. H_2CS was later found in Sagittarius B by the CSIRO Radiophysics Laboratory in Australia.

Another strand of research has grown out of the critical reviews of data. That is, measurements are being made on the characteristic frequencies of several molecules (as was done in the case of dimethyl ether) to supplement the literature and thus to provide more complete spectral information.

In attempting to produce in the laboratory molecules of actual or possible astronomical interest, it is not practical to simulate the interstellar condition of extremely low density. Instead, the NBS scientists have adopted the strategy of taking a suitable starting substance and breaking it up by pyrolysis at temperatures around 1000° C. Then they study with a microwave spectrometer the characteristic frequencies of the resulting gas-phase products as they move swiftly through the absorption cell.

In a study of this kind now in progress, the starting substance is ethylamine ($C_2H_5NH_2$). In this case, eight product molecules have been predicted, four of which have never before been observed. To date, two of the new molecules have been detected and their chemical structures determined.

By displaying the output of the microwave spectrometer on the screen of an oscilloscope, one can see which molecules are present and in what relative amounts. One can also watch what happens to the relative amounts as the temperature of the pyrolysis tube is changed. It is then possible, for example, to adjust conditions for maximum production of a given molecule.

Industrial Scene

Two scenes have occupied our attention to this point: the interstellar molecular clouds and the microwave spectroscopy lab. One other remains to be mentioned—the chemical plant, where the knowledge gained in these studies will undoubtedly find applications.

In the short term, the spectroscopically monitored continuous-flow technique for studying gas-phase molecules could well be used right now to present continuous information about the changing concentrations of different substances at strategic places in chemical processing schemes.

It has been suggested, for example, that it could be used in petroleum processing plants that crack heavy hydrocarbons, where a catalytic surface is employed which becomes contaminated with use. By siphoning off a small sample of the mix and displaying its composition on an oscilloscope screen, one would know the state of the surface from moment to moment, and therefore be in a position to replace the surface with minimum waste of time and materials.

In the long term, the work with unknown molecules opens up potentially unlimited perspectives. Though short-lived themselves, it may be possible to use these molecules in building others that are stable, and so to produce new families of materials with novel properties. □

HIGHLIGHTS

Fire Protection Master Plans

The Bureau has awarded $127,000 to the Los Angeles and Mountain View, Calif., fire departments to develop a method for preparing master plans for community fire protection.

This year-long project should result in a set of procedures that fire departments around the country can use in developing master plans suited to their own communities.

Measurement Science in Transition

Engineers and scientists will explore an interdisciplinary approach to measurement problems at the 1974 Joint Measurement Conference to be held at NBS, Gaithersburg, Md., on November 12-14.

The purpose of the conference is to promote the flow of information available in one field to other fields in which it can be applied. As the keynote speaker, Dr. Ernest Ambler, deputy director of NBS, will discuss "Measurement Science in Transition: From the Laboratory into our Daily Lives." For information, contact Joseph Cameron, A345 Physics Bldg., NBS, Washington, D.C. 20234.

Two New SRM's Issued

Two new Standard Reference Materials (SRM's) have been certified for their electrical resistivities as a function of temperature. Both of these SRM's are intended for use in calibrating knife edge and other similar electrical resistivity apparatus.

SRM 797, electrolytic iron, is a medium conductivity standard with a resistivity ratio of 23.5. Measurements performed on the austenitic stainless steel, SRM 798—a low conductivity standard, show a resistivity ratio of 1.32.

Details are given in NBS Special Publication 260-47, which is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 55 cents. Order by SD Catalog No. C13.10:260-47.

Solar Energy Systems

The Department of Housing and Urban Development (HUD) has requested the NBS Center for Building Technology to develop performance-based criteria for solar energy systems. Under the terms of an interagency agreement, NBS will prepare heating and cooling criteria to be used in the design and evaluation of solar energy systems, the first step in an effort to demonstrate solar energy heating and cooling of housing on a large scale. NBS will establish an advisory panel to review the draft criteria during development and prior to dissemination by HUD.

Flammable Research Award

The NBS Experimental Technology Incentives Program (ETIP) recently awarded Clemson University $474,821 to develop further flame resistant cotton/polyester fabrics. The main objectives of the project are to improve the technology of preparing flame retardant fabrics made from cotton/polyester blends and to insure that new theory and practice are rapidly coupled in commercial practice.

Rare Earth Iron Alloys Studied

The basic origin and significant features of the magnetic ordering in amorphous rare earth iron alloys are being investigated by researchers engaged in a collaborative NBS-Naval Ordnance Laboratory program at the NBS reactor. These materials, which have indicated promise for both permanent-magnet and computer memory application, were prepared by rapid sputtering and were first shown to be amorphous from neutron scattering studies at NBS.

Fire Reporting System

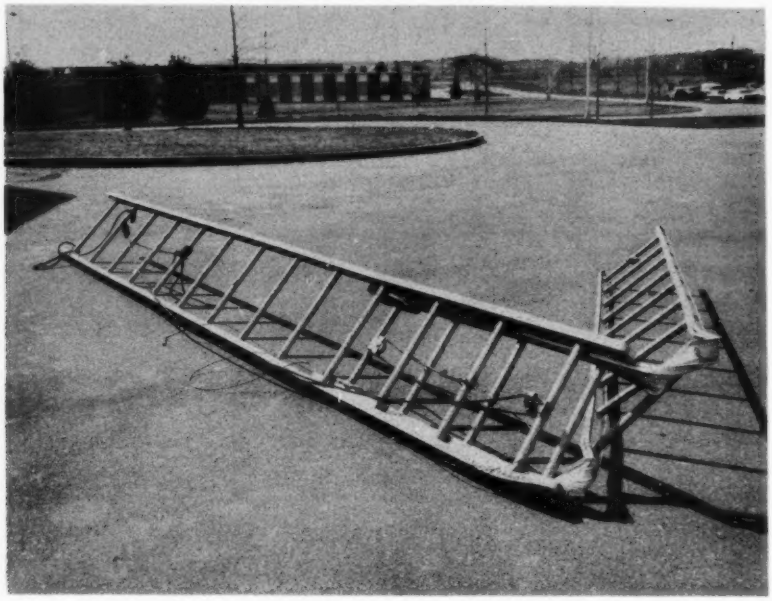
A pilot system for the reporting of fire incidents has been inaugurated by NBS' Programmatic Center for Fire Research in cooperation with 10 selected fire protective agencies around the Nation. These agencies, which are representative of fire authorities at city, county and State levels of government, will be working with NBS to develop the methodology necessary to establish a nationwide reporting system.

Barrier Penetration Tests

A recent NBS study tested 16 structural barrier panels to determine their resistance to forcible penetration through the use of such common tools as sledgehammers, saber saws and electric drills. The degree of protection given to computers, money or negotiable securities, weapons, classified materials or other valuable items is dependent upon the effectiveness of the physical security measures that are employed to safeguard them.

Results of the study are published in NBS Technical Note 837, Barrier Penetration Tests. It is available as SD Catalog No. C13.46:837 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $2.15. □

New Standards for Ground Ladders Urged



A NEWLY released study by the National Bureau of Standards finds that ground ladders used by fire departments can be "demonstrably unsafe" under severe use conditions. Ground ladders are those which are hand carried and raised manually. They are used on lower levels of a building during fires.

The 73-page study, prepared by NBS' Programmatic Center for Fire Research, notes that metal ground ladders used by fire departments often "have not been designed to withstand the service conditions of firefighting."

The report contends that the existing voluntary standard for such ladders is inadequate and points out means of improving it. In fact, says Harvey P. Utech, author of the preliminary study, the existing standard on fire department ladders is less rigorous than the standard for general purpose, heavy duty portable metal ladders of the type used by commercial painters.

In the report, Utech recommends that the standard be upgraded "to reflect accurately the performance demands likely to be made on these ladders." As an immediate step, he suggests that the standard for ground ladders incorporate many of the performance requirements or test procedures already in effect for heavy duty straight and extension ladders in general use. A second step would be the incorporation of several new performance tests specifically designed to reflect the demands made upon ladders in a fire situation. Among these is a test to determine ladder performance and strength during exposures to high temperatures.

In addition, the report notes, prolonged exposure to high temperatures may cause some ladders, particularly those of aluminum, to lose load-bearing strength. For this reason, the report says, fire departments should check their aluminum ground ladders regularly for hardness, using a portable metal hardness tester. Since aluminum's hardness can be directly related to its strength, this procedure will permit weakened ladders to be identified and replaced before they fail, perhaps during a fire.

The report also notes that the existing standard does not provide an adequate test of the load-carrying capacity for ladders used by firemen. In both cases the ladder appeared to have passed all the current test requirements, "but failed in normal use with two men on them," the report states. In one case, a fireman was reported seriously injured when a 10.7 meter (35-foot), fully extended ladder collapsed. Utech describes subsequent investigations by NBS metallurgists in which they reportedly uncovered defects sufficient in both cases to cause the ladders to fail, but not sufficient to be detected by the test methods in the present standards.

Printed copies of the study, NBS Technical Note 833, "Fire Department Ground Ladders—Results of a Preliminary Study," may be ordered prepaid for $1.20 and by SD Catalog No. C13.46:833 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Foreign remittances must be in U.S. exchange and include an additional 25 percent of the publication price to cover mailing costs. Order microfiche copies prepaid by NTIS No. COM-74-50457 from the National Technical Information Center, Springfield, Va. 22151; the price is $1.45 (domestic) or $2.95 (foreign) a copy. □

Time and Frequency Texts Published

A COMPREHENSIVE collection of information, theory and data on time and frequency standards and research has just been published by the National Bureau of Standards.

The collection comprises one monograph and three technical notes compiled by the Time and Frequency Division of NBS and covers the subjects of precise time and frequency generation, dissemination, theory, research and history. Contributions to this work were also made by the U.S. Naval Observatory (USNO) and other government agencies.

NBS is charged with providing the primary standard of frequency and time interval for the United States while the USNO is the primary U.S. source of precise time-of-day information.

The 470-page Monograph 140, entitled *Time and Frequency, Theory and Fundamentals*, describes the field of time and frequency (T/F) research, from basic elemental concepts of the measurement of time to the most recent developments in precision timekeeping based on atomic and molecular resonances.

Chapter topics include quartz crystal oscillators, the history and present state of the art of atomic frequency standards (especially cesium beam standards), promising areas of future T/F research, the relevance of accurate frequency measurements to other areas of science and technology, the statistics of T/F data analysis and methods of disseminating T/F information. The goal of Monograph 140 is to present a broad overview of the whole T/F field in a practical, understandable form useful as a tutorial reference to both new and experienced workers in the field.

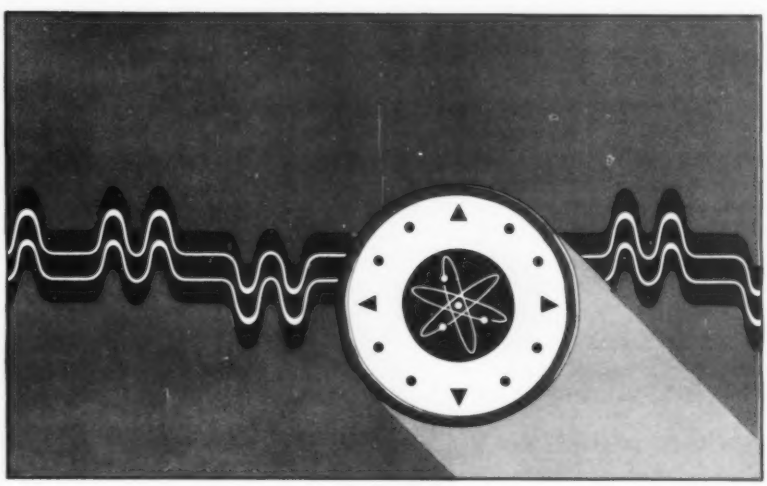
One chapter, "The Standards of Time and Frequency in the USA," has been published separately as NBS Technical Note 649. It describes the national responsibilities for standards of time and frequency of NBS and the U.S. Naval Observatory, the two agencies chiefly involved in distributing time and frequency information in the United States.

Technical Note 616 (Revised), *Frequency Standards and Clocks: A Tutorial Introduction*, explains the concepts of time, frequency, frequency stability and accuracy and describes the general physical principles and features of modern T/F standards and clocks. It discusses in detail the performance and limitations of quartz crystal oscillators and atomic devices (hydrogen, cesium and rubidium) and compares their utility as laboratory and field-usage standards.

Technical Note 656, *Standard Time and Frequency: Its Generation, Control, and Dissemination by the NBS*, describes the means by which NBS provides the public with standard T/F signals. Since the primary frequency standards NBS-4 and 5 and their associated equipment are elaborately described elsewhere, this publication concentrates more on the techniques or processes of transferring the T/F information to the public. This is done primarily via radio stations WWV, WWVH and WWVB on a continuous basis, and WWVL on an experimental, noncontinuous basis.

These publications may be ordered from the U.S. Government Printing Office, Washington, D.C. 20402 as:

- NBS Monograph 140—SD Catalog No. C13.44:140 for $8.65.
- NBS Technical Note 616 (Revised)—SD Catalog No. C13.46:616 (Revised) for $.70.
- NBS Technical Note 649—SD Catalog No. C13.46:649 for $1.00.
- NBS Technical Note 656—SD Catalog No. C13.46:656 for $.35. □



World War III Being Fought with Computers?

A LEADING government computer authority believes the first battles of World War III have already been fought . . . with computers rather than cannons.

This view is held by Dr. Ruth M. Davis, director of the National Bureau of Standards' Institute for Computer Sciences and Technology, the Federal focal point for computer research and applications.

Discussing "Computers and the International Balance of Power" in an address to the Congress of the International Federation of Information Processing Societies at its recent meeting in Stockholm, Davis said:

"World War I was fought with chemistry. World War II was fought with physics. World War III is being fought with computer science. The first battles of World War III may well have occurred when mathematical formulations of strategies and counter-strategies of realistic proportions were able to be tried out as war games on computers.

"With realistic wars being able to be fought in 20 minutes or 20 hours on computers, decisions to engage in such encounters have been nil. No statistical correlations are needed to validate the fact that no major encounters have occurred between 'large computer-possessing' nations."

Davis pointed out that, "Man has attempted to use the computer to help him understand himself, to help him gain more intelligence and power and to replace himself in performing tasks demanding intelligence and the capability to control. It is this varying and contradictory role that we have ourselves assigned to computers that results in a great deal of the honest confusion, mistrust and fear surrounding computers.

"There is presently no balance between man and computer that possesses any permanence. The changing balance reflects the changing roles man is assigning both to himself and to computers."

And she warned, "Until the day comes when science finds a way of installing a conscience in every computer, we must develop human, personal safeguards that prevent computers from becoming huge, mechanical, impersonal robots that deprive us of our essential liberties."

Davis noted that the United States presently has 134,000 computers, one and one-third more than the rest of the world combined. International computer capability is accelerating, through applications which vault national boundaries.

These include the International Telecommunications Satellite, the Earth Resources Technology Satellites and the multi-national impact of the Electronic Funds Transfer Systems in banking and the Electronic Point of Sale systems in retailing.

Recognizing the growing international importance of computers, Davis pointed out that:

- Computer technology is a most effective technology for shifting balances of power and status quos without the catastrophic or dangerous effects characteristic of military technologies.
- Those communities, power groups or nations using computer technology as an agent for change may be the most effective in achieving their objectives today and in the future.
- The importance of computer technology in the international scene makes it imperative that computer scientists and technologists become far more active spokesmen in providing advice to leading policy-makers world-wide.

"In view of the rapidly changing international scene, accompanied by the importance and 'newness' of computer science and technology," Davis said, "it is most important that progress be made with all deliberate speed on the international front by spokesmen for computer science and technology." □

Workshop on Standardization and Measurement Services to be Held

THE Agency of International Development, the Organization of American States and the National Bureau of Standards will cosponsor a workshop on "Standardization and Measurement Services in Industrializing Economies" from November 2 through November 16, 1974. The workshop is one of a series offered to provide less industrialized countries with insights into the standardization and measurement systems used in the United States. This year's workshop is intended to serve more countries than the previous three workshops, and a particular effort is being made to include a large number of Latin American representatives.

The visiting standards and measurement officials will divide their time between selected Washington-area laboratories and technical facilities in Philadelphia, Boston, Chicago, Madison, Wisc., and Boulder, Colo.

Standardization and measurement questions and problems from both past and current experience of the United States will be compared with similar issues encountered by overseas officials in carrying on their countries' programs. Key questions in the standardization area include the development of voluntary or mandatory consensus standards, and the maximum harmonization of local, company, national, regional and international standards. Mutual certification for compliance to standards allows countries to market their products in international trade with considerable savings of cost and effort. In the measurement area, nations should limit laboratory and test services to measurements appropriate to their industry and commerce.

At the workshop, the views from the United States will be presented by NBS specialists, spokesmen from the National Technical Information Service, the Department of Agriculture, the Food and Drug Administration and many representatives from Universities and independent industrial and testing laboratories. □

First NBS-AIA Research Resident Named

THE National Bureau of Standards and the American Institute of Architects (AIA) have announced the name of John K. Holton as the first research architect to be appointed under the recently established AIA-NBS architect-in-residence program.

In making the joint announcement NBS Director Richard W. Roberts and AIA President Archibald Rogers, said, "John Holton is distinguished in his field. He is an excellent choice to inaugurate the research-architect-in-residence program. "We are confident that Holton, and others who follow him, will establish new levels of communication between NBS and the architectural profession. Each side has much to offer the other."

Holton is associated with the Mark VII Corporation, a joint venture of Perkins and Will, architects, engineers and planners, and Borg Warner Corporation. He is the director of physical planning and design for West Valley, a new town of 65,000 being developed by the firms in Kane County, Ill. Holton directs a staff of 40 professionals in town planning, architectural design, engineering, solid waste management, surveying and mapping, and noise, air and water pollution control.

Holton has had extensive design experience in residential housing units, particularly in the field of modular housing. He has also planned and designed numerous medical centers and educational institutions. He is a recognized consultant in modular housing, and in 1968, was asked to make a presentation to the President's Committee on Urban Housing. At NBS, Holton will be active in both research and liaison. In addition to individual research, he will act as a research resource for ongoing projects and programs at NBS.

The NBS-AIA program affords a distinguished, practicing architect the opportunity to spend 1 year at NBS doing research. The candidate is selected by a joint NBS-AIA committee consisting of representatives from the architectural profession and the scientific community. The program will be described in detail in a subsequent issue of the AIA Journal. □

New Metrology Guide Series Begun

THE National Bureau of Standards has initiated a new series of measurement publications known as Metrology Guides. These guides, written and published by experts in measurements, will provide teachers, design engineers, contract monitors, and practicing metrologists who haven't the time to do their own research and study with information about quantitative electromagnetic techniques.

NBS' Electromagnetics Division has recently published the two first volumes in the series—"The Measurement of Lumped Parameter Impedance; A Metrology Guide" and "The Measurement of Noise Performance Factors; A Metrology Guide." Each guide presents a terse, authoritative comparison of measurement methods for a given electromagnetic quantity or subtopic of that quantity. Emphasis is on a format that makes it easy to compare salient features of various methods, their relative value and how they affect performance.

Whereas NBS usually chooses and develops measurement techniques that will yield the highest accuracy and precision attainable, engineers and scientists in the electronic industry must consider tradeoffs among parameters. Typical of such parameters are reliability, dependability, cost, user knowledge, maintenance and equipment required.

Although not all these parameters can be adequately covered in any one guide, their consideration is considerably aided by surveys that outline and critically compare techniques. This permits the user to more efficiently recognize those methods that will repay further study on his part.

Each guide is prepared by an NBS measurement specialist and is based upon an extensive literature search. The resulting comparison of various measurement methods provides guidance for the user in selecting, applying and evaluating those methods that are suitable for a particular application.

The subject matter of each guide includes:

1. Physical principles underlying the measurement technique.

2. Obtainable accuracy for each method, indicated either by typical ranges and accuracies or the error equations.

3. Strength and weakness of each technique including sources of error and, wherever possible, the error equations of specific operating systems.

4. Instrumentation requirements (including standards) for each technique.

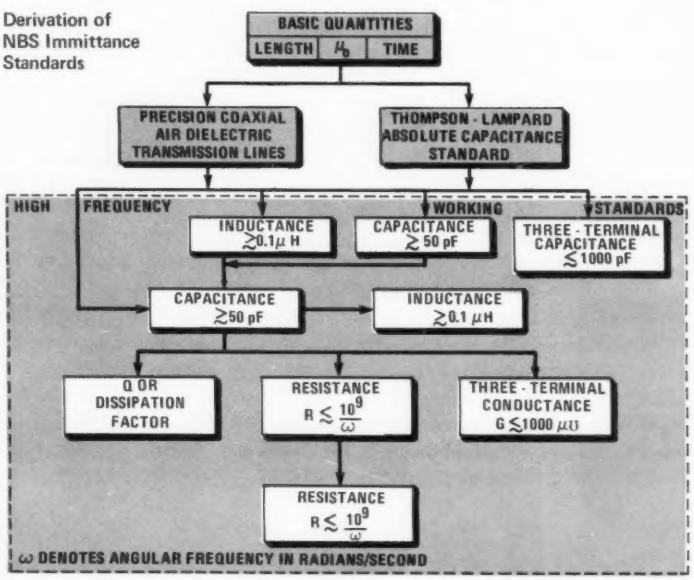
5. Operational problems, suggestions or examples.

6. An extensive bibliography to assist the user in pursuing details that go beyond the guide.

Topics proposed for future metrology guides include:

- A guide to automating precision electrical measurements.
- Microwave-impedance measurements.
- Measuring pulse time-domain parameters.
- Measuring modulation noise.
- Evaluating shielded enclosures.
- Near-field antenna and radiation-hazard measurements.

The first two metrology guides are available through the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. NBS Monograph 141, "The Measurement of Lumped Parameter Impedance; A Metrology Guide," can be ordered as SD Catalog No. C13.44:141 for $5.50. "The Measurement of Noise Performance Factors; A Metrology Guide," NBS Monograph 142, is available as SD Catalog No. C13.44:142 for $5.45. □



INDUSTRY *continued*

EPIC opens with a description of how a company can initiate and implement an energy conservation program. An outline for setting up a program is supplemented by a series of detailed memoranda, letters and intra-company reports explaining precisely how an energy conservation program is set up in a sample company.

The next section of EPIC is a checklist of some 180 energy conservation opportunities (ECO's). ECO's are one-sentence tips suggesting specific ways to save energy in twelve functional and operating areas. The areas are building and grounds, electric power, steam, other utilities, heat recovery, heat confinement, combustion, scheduling, materials handling, process changes, commercial practices and shipping, distribution and transportation.

Success Stories

The checklists of ECO's are supported and referenced by actual case histories illustrating how energy savings have already been achieved in many organizations. Success stories abound in the guide. For instance, one detailed description shows how a midwestern meat packing plant saved 27,000 million BTU's of fuel oil—worth about $21,600—per year by heating it to the proper temperature. Another sample illustrates how a shopping center reduced energy used in lighting a parking lot area by 56,600 kilowatt hours per month for a savings of $350 each month.

Illustrations are based on a specific industrial and commercial experience or are representative of several experiences. In addition to a brief description of the action taken to achieve energy savings, the reports include graphs, tables and sample calculations from which a company can estimate its potential for saving energy and reducing costs.

The other sections of EPIC provide supporting information which would be useful in a conservation program. Sections are devoted to:

- Data and conversion factors pertinent to energy conservation.
- Financial analysis procedures for evaluating projects.
- Sources and organizations to contact for information on energy conservation.
- Possible safety, health and pollution considerations that may impact on conservation measures.
- Techniques for developing employee participation in an energy conservation program.
- A brief guide to the existing technology and instruments for measuring energy-related flows.
- A bibliography of energy conservation articles.

EPIC itself is designed as a prepunched handbook with sections that can be pulled apart and placed in a loose-leaf notebook. This makes it possible for users to pick and choose the information from EPIC they need and that fits their operation. Although EPIC is intended to be most useful to the management of small to intermediate sized firms which do not have an established energy conservation program, the guide will also be useful to managers of large companies and of companies with ongoing energy conservation programs.

U.S. energy consumption.

Field Testing

A variety of activities to expand EPIC and to facilitate its widespread implementation are planned for FY 1975. These FEA-funded efforts include field testing of EPIC, public awareness campaigns and training programs and university short courses. The EPIC document is being marketed for NBS by the Commerce Department's Office of Energy Programs, which will work with university and industry contacts in their efforts.

NBS plans to update EPIC with supplements as more information becomes available from companies which have successful energy conservation programs. Contributions are solicited for possible inclusion in supplements and can be made by contacting the Office of Energy Conservation, Center for Building Technology, National Bureau of Standards, Washington, D.C. 20234. Copies of the NBS Handbook 115, Energy Conservation Program Guide for Industry and Commerce, may be ordered by sending $2.50 per copy (check, money order or Supt. of Documents coupons) to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Please use Supt. of Documents number C13.11:115 when ordering. A 25% discount on orders of 100 or more is offered. □

had indicated their intention of participating in the program and applying the labels to their products.

Monitoring of the program in order to insure manufacturers' compliance with the labeling specifications is limited to evaluating complaints received from competitors and consumers. NBS will have access to all test data for this purpose and can order that tests be made on questionable items. Additionally, any deliberate misstatement of facts on a label may be subject to action by the Federal Trade Commission.

The only penalty called for under the program procedures for any manufacturer who intentionally deceives is to terminate his participation in the program—and then only after adequate safeguards of his rights.

Room Air Conditioner Label

The Energy Efficiency Ratio, or ERR, was chosen as the method for rating efficiency of room air conditioners. We scrutinized this method very carefully and compared it with other possible rating schemes. We found the EER had several advantages, including the fact that it has long been accepted by the industry. But most importantly, consumer surveys indicated to us that the EER concept was not difficult for consumers to understand and that the EER number was meaningful, as it appears on the label.

The range of efficiencies, expressed as EER, for all room air conditioners having similar cooling capacity is indicated on the label. We consider this an extremely important feature of the label, because it enables the consumer to readily determine how a particular model air conditioner compares in efficiency with all competing models. We intend that data presented on labels for other appliances brought under the program will allow similar comparison of a particular unit with the energy efficiencies offered by its competition.

Development of Refrigerator/Freezer Label

The second appliance group to be brought into the labeling program includes refrigerators, refrigerator-freezers and freezers. The first task in developing the label specification, as always, involves selection of the test method, or rating scheme. Several variables within this class of products, which would have bearing on the range of variation in energy efficiency, were recognized. These include the capacity of the unit, and whether it has a manual, frost free or automatic system.

Unlike the case of room air conditioners, in which the EER was a generally accepted means for expressing energy efficiency within the industry, there exists no similar consensus on tests for refrigerators and freezers. Consequently, we are employing actual use data that we have gathered in order to select a test method that is generally acceptable and that will be a reasonable reflection of conditions found in the typical American home.

Factors in Rating Scheme Selection

There would, of course, be some real advantage in terms of simplicity if a common rating system could be applied uniformly to all products. But the fact is that, given the variation in significant operating characteristics for the various appliances, differences in requirements on the part of the consumer among the different classes of products and local differences in energy costs, no such simple and universally applicable rating scheme seems feasible. Our problem in this regard may be compounded in the case of water heaters and certain other items of equipment where we encounter the use of more than one fuel. For example, how do you directly compare the efficiencies of two water heaters, one using gas and the other electricity?

The Future

The current effort for publishing proposed and final specifications is planned to extend well into calendar year 1976. It is possible, perhaps even probable, that developmental efforts in the energy labeling field will continue well beyond 1976 as additional products may be brought into the program, or as current Congressional interest in energy labeling is translated into specific legislative requirements. Indeed, the Administration is supporting legislation that would require energy labeling for certain appliances. This legislation would, in effect, give our present voluntary labeling program mandatory status.

It appears that energy labeling is a fact to be increasingly reckoned with by industry, and one that hopefully, will be well-utilized by consumers. Labeling has the potential for engaging every citizen and consumer in the conservation effort, while preserving and even enhancing choice in a free market. □

AVOGADRO *continued*

density measurements with uncertainties well below 1 ppm will soon become commonplace.

An Atomic Standard of Mass?

In the last paragraph of their paper on the NBS Avogadro constant experiment (Phys. Rev. Letters, 19 Aug. 1974), the NBS scientists point out that, in the light of recent developments, it would appear possible to determine the Avogadro constant with still greater accuracy—to a part in 100 million. And they conclude: "Should this be achieved, one might wish to assert that the artifact kilogram is redundant and that masses can be obtained via an algorithm of realization from the atomic mass unit."

Although such a redefinition of the kilogram in terms of an atomic standard may not come about for some time, it may be of interest to see how an atomic definition would operate.

To preserve continuity with past measurements, the uncertainty in N_A must not exceed the uncertainty associated with the present kilogram standard. Hence the need to wait until N_A is known to a part in 100 million.

Assuming we have measured N_A with the required accuracy, the unit of mass can be fixed by assigning this value to N_A by definition. And if a substance has the molecular weight M, N_A molecules of that substance would, by definition, have a mass of M grams (= M/1000 kilograms).

The mass (m) of a given crystal specimen, in terms of the new definition, could then be found by measuring its volume (v) and using the Bragg equation in the form:

$$m = \rho v = (nA/N_A a_0^3)v$$ □

PUBLICATIONS
of the National Bureau of Standards

Computer Science and Technology

Jeffery, S., **Information Handling Needs Within the U.S. Patent Office,** Nat. Bur. Stand. (U.S.), Tech. Note 834, 17 pages (June 1974) SD Catalog No. C13.46:834, 55 cents.

Consumer Information and Protection Health and Safety

Moore, R. T., **Barrier Penetration Tests,** Nat. Bur. Stand. (U.S.), Tech. Note 837, 191 pages (June 1974) SD Catalog No. C13.46:837, $2.15.

Utech, H. P., **Fire Department Ground Ladders—Results of a Preliminary Study,** Nat. Bur. Stand. (U.S.), Tech. Note 833, 82 pages (July 1974) SD Catalog No. C13.46:833, $1.20.

Consumer Information and Protection Product Information

Newell, K. G., Jr., **Cellulosic Fiber Insulating Board. (ANS A194.1-1973),** Nat. Bur. Stand. (U.S.), Prod. Stand. 57-73, 8 pages (Nov. 1973) SD Catalog No. C13.20/2:57-73, 40 cents.

Engineering and Information Standards

McEwen, H. E., **Countries, Dependencies, and Areas of Special Sovereignty,** Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS PUB) 10-1, 27 pages (1974) SD Catalog No. C13.52:10-1, 70 cents.

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